Claims

[c1] What is claimed is:

1.A thermal control system having an initial bore condition and a thermal boundary condition for an MRI comprising:

a thermal controller adapted to set at least one dynamic limit on a power input into at least one gradient coil of the MRI, said at least one dynamic limit being a function of the initial bore condition and the thermal boundary condition.

[c2] 2.The system of claim 1 wherein at least one temperature sensor is adapted to sense the initial bore condition and therefrom generate an initial condition signal and said at least one temperature sensor further adapted to sense the thermal boundary condition and therefrom generate a thermal boundary signal.

[c3] 3.The system of claim 2 wherein said at least one temperature sensor comprises a first temperature sensor adapted to sense the initial condition and therefrom generate said initial condition signal and a second temperature sensor adapted to sense the thermal boundary and therefrom generate said thermal boundary signal.

[c4]

4.The system of claim 1 wherein said thermal controller sets said at least one dynamic limit by receiving at least one gradient field;

converting said at least one gradient field command into a power level signal;

generating a model of said power level signal,

generating a model change in a gradient temperature from said model of said power level signal;

generating an initial bore condition signal from a temperature sensor coupled to the MRI;

generating a gradient temperature signal from a sum of said initial bore condition signal and said model change in said gradient temperature;

generating a change in bore temperature signal through summing said model of said power level signal and a model of said current bore temperature generated from said gradient temperature signal summed with said bore temperature signal;

summing a second boundary condition with said change in bore temperature to

generate said current bore temperature; and
adjusting a gradient field.

[c5] 5. The system of claim 1 wherein said thermal controller is adapted to set said at least one dynamic limit through a thermal predictor software module, which includes a computational algorithm for modeling a series of coupled first order dynamic subsystems designed to simulate at least one actual thermal characteristic of the MRI.

[c6] 6.The system of claim 1 further comprising a gradient coil control actuator adapted to adjust a gradient field of said at least one gradient coil in response to an activation signal from said thermal controller generated in response to said dynamic limit

7.A method for controlling thermal behavior in an MRI system comprising:
inputting at least one gradient field command into an embedded thermal controller;
converting said at least one gradient field command into a power level signal;
generating a model of said power level signal,
generating a model change in a gradient temperature from said model of said power level signal;
generating an initial bore condition signal from a temperature sensor coupled to the MRI;
generating a gradient temperature signal from a sum of said initial condition signal and said model change in said gradient temperature;
generating a change in bore temperature signal through summing said model of said power level signal and a model of said current bore temperature generated from said gradient temperature signal summed with said bore temperature signal;
summing a second boundary condition with said change in bore temperature to generate said current bore temperature; and
adjusting a gradient field.

[c7]

8.The method of claim 7 wherein inputting at least one gradient field command into an embedded thermal controller further comprises inputting gradient fields

resultant from a superconducting magnet used in conjunction with a magnetic gradient coil assembly, which is sequentially pulsed to create a sequence of controlled gradients in a main magnetic field during a MRI data gathering sequence.

[c8] 9.The method of 7 wherein converting said at least one gradient field command into a power level signal further comprises converting said at least one gradient field command into a plurality of power level signals in response to internal resistances and gains.

[c9] 10.The method of claim 7 wherein generating a model of said power level signal comprises generating a plurality of transfer functions as a model of said power level signals.

[c10] 11.The method of claim 7 wherein generating a model change in a gradient temperature from said model of said power level signal further comprises summing said plurality of transfer functions to generate said change in said gradient temperature signal.

[c11] 12.A method as in claim 7 wherein adjusting a gradient field comprises adjusting a gradient field by at least one of a responsive computer control unit or a manual adjustment.

[c12]

13.An MRI thermal control system comprising:
a gradient coil coupled to the MRI;
at least one temperature sensor adapted to sense an initial bore condition and therefrom generate an initial bore condition signal and said at least one temperature sensor further adapted to sense a thermal boundary and therefrom generate a thermal boundary signal;
gradient coil control actuator adapted to adjust a gradient field of said gradient coil; and
an embedded thermal controller adapted to receive said initial condition signal and said thermal boundary signal, said embedded thermal controller further adapted to set at least one dynamic limit on power input into said gradient coil in response to said initial condition signal and said thermal boundary signal,

said embedded thermal controller further adapted to activate said gradient coil control actuator in response to said dynamic limit.

[c13] 14.The system of claim 13 wherein said at least one temperature sensor comprises a first temperature sensor adapted to sense said initial condition and therefrom generate said initial condition signal and a second temperature sensor adapted to sense said thermal boundary and therefrom generate said thermal boundary signal.

[c14] 15.The system of claim 13 wherein said gradient coil control actuator is adapted to adjust an input power to avoid an over-limit condition within said gradient coil when energetic scanner use causes high temperatures.

[c15] 16.The system of claim 13 wherein said embedded thermal controller is adapted to set at least one dynamic limit through inputting at least one gradient field command into said embedded thermal controller;
converting said at least one gradient field command into a power level signal;
generating a model of said power level signal,
generating a model change in a gradient temperature from said model of said power level signal;
generating an initial bore condition signal from a temperature sensor coupled to the MRI;
generating a gradient temperature signal from a sum of said initial condition signal and said model change in said gradient temperature;
generating a change in bore temperature signal through summing said model of said power level signal and a model of said current bore temperature generated from said gradient temperature signal summed with said bore temperature signal;
summing a second boundary condition with said change in bore temperature to generate said current bore temperature; and
adjusting a gradient field.

[c16] 17.The system of claim 13 wherein said embedded thermal controller is adapted to set at least one dynamic limit through a thermal predictor software module, which includes a computational algorithm for modeling a series of coupled first

order dynamic subsystems designed to simulate at least one actual thermal characteristic of the MRI.